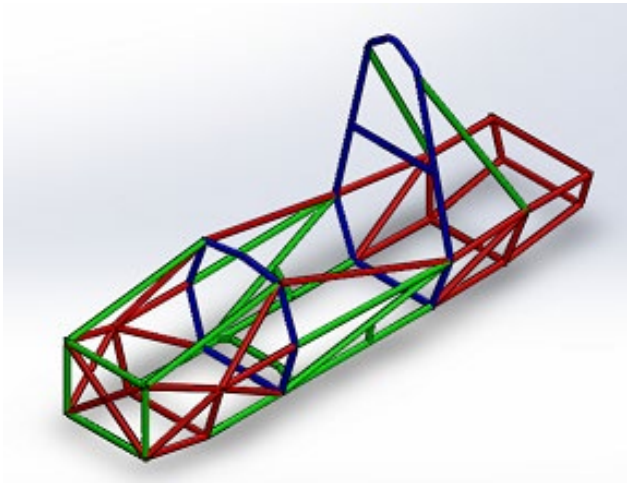
SES
(Structural-Equivalency-Spreadsheet)

F.3.1-4 Tube Chassis



What is SES？

SES : Structural-Equivalency-Spreadsheet

⇒Calculations proving structural equivalence

○SES definition

F.2.1 Structural Equivalency Spreadsheet - SES
F.2.1.2 The SES provides the means to:
a. Document the Primary Structure and show compliance with the Formula SAE Rules
b. Determine Equivalence to Formula SAE Rules using an accepted basis

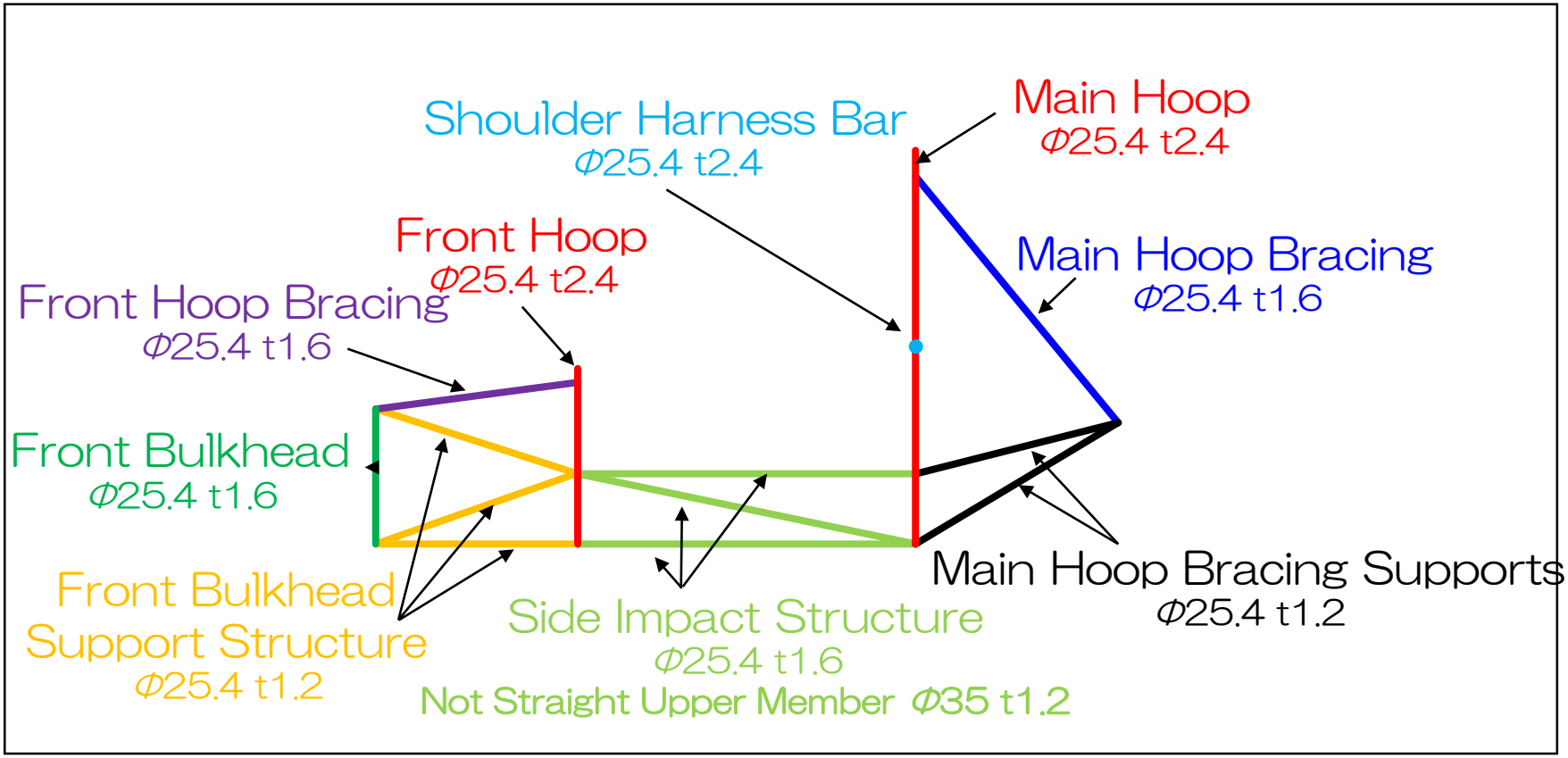
○Purpose of the SES

FSAE Rules, Part F describes the minimum requirements that the Primary Structure should meet, and the SES is a sheet to prove it at the design level.
It is desirable to be able to submit a highly complete SES from as early as possible, as the SES review has the role of early detection of rule non-compliance at the design stage and avoids fatal rework of the frame.

What is SES？

SES is a calculation document to prove that it is equal to or higher than the standard structure shown below.

This should be taken into consideration when filling out



The Primary Structure is the last bastion to protect the driver's life in case of emergency. Failure to pass the SES inspection is nothing other than designing a dangerous vehicle that cannot guarantee even the minimum level of safety. Keep this point in mind.

SES guidance：at first

First, understand the precautions in this part

2023 FSAE Structural Equivalency Spreadsheet (SES), includes Impact Attenuator Document (IAD) **Steel Tube** **1.1** Acc F

There are two versions of the 2023 SES: Steel Tube and Monocoque/Hybrid/Non-Ferrous.
Aluminum equivalance may be used in the Steel Tube SES for Anti-Intrusion, EV Rear Impact, or Accumulator Containers and Mounting.
Steel can be used for any part of the frame in the Monocoque/Hybrid/Non-Ferrous SES.
F.3.4.2 - Any and all steel grades are assigned the same material properties. No material properties for different grades may be used in the SES.
Teams using multiple chassis in one season: Comment below the SES submission with a link to the SES for the second chassis, before the Action Deadline.

Only cells of this color can be edited. Enter all values as positive numerals.
Drop down options can be identified by the heavy border. Delete will clear the entry.
Each entry, each category, each tab, and the entire sheet are coded as one of the following: BLANK EQ CHECK REJECT N/A
The status of some cells depends on entries in other cells.

SELECT YOUR UNITS. The entire SES will be completed in either mm or Inch. Inch tubing can be entered in mm, and vice versa.
Keep a copy of the rules open to reference rule numbers directly while filling out the SES.
Fill in all **BLANK** sections on **ALL TABS.** Start with any drop downs in the top left corner of each tab.
Replace example images with your own clear, undistorted CAD, showing all required dimensions in a moderate filesize. **Each SES file 25Mb max.**
Read the additional guidance on the right side of this sheet.

F.2.2.1 SES forms must be completed and submitted by all teams no later than the date specified in the Action Deadlines on the specific event website.
DR.3.2.1 Submission of late, blank, incomplete, or previous car's SES will incur a competition point penalty.
DR.3.1.2.b Do not submit an updated document after the deadline without having the previous document rejected.
DR.3.1.2.b Submit a comment requesting a rejection on your team's SES page on fsaeonline.com. Submissions or comments on FSAEonline.com will send a notification to your re
DR.3.1.3 Please respond quickly and thoroughly to requests for revisions or clarifications. Your team's response time influences Tech Inspection order.
IN.8.1 Bring an **ELECTRONIC** copy of the approved SES to Tech Inspection. It is your responsibility to bring a functioning, charged tablet or laptop. Bring backups. **DO NOT F**
IN.1.4 Approval of an SES does not guarantee passing Tech Inspection. The final decision about all designs will be made at Tech Inspection.

- Input items are pink cells
- Cells with thick borders are selected from the dropdown
- The input item must be "EQ"
- Present a drawing that shows the evidence for the entered numerical value.

Cover

Enter basic items

University Name					BLANK
Team Name					BLANK
Competitions	May IC	June IC	June EV	Japan	EQ
Car Numbers					BLANK
Team Contact(s)					BLANK
Email Address(es)					BLANK

Enter "Japan"

	Chassis Rules	Powertrain	
s	Select Drop Down	Select Drop Down	EQ / BLANK

The team that selected "Other Equivalence", Create an SES by referring to the separate document: "2023_SES Guidance_Monocoque".

Ready to submit for review? NO

F.3.1-4 Tube Chassis	BLANK	BLUE: NO. BLANK ENTRY. INCOMPLETE. CHECK ALL TABS.
F.10-11 EV Accumulator	BLANK	This will not change until all required entries are filled out. Check all tabs.
F.8 Front Protection	BLANK	Incomplete submissions will incur a penalty.
F.3.4.3 Welded Inserts	BLANK	BROWN: NO. GROUNDS FOR REJECTION. CHECK ALL TABS.
F.5.12 Bolted Members	BLANK	The SES will permanently REJECT for removing any tab. Fill out a fresh copy.
		Locate all violations and bring the design into compliance before submitting.
		Grounds for rejection could be considered incomplete and incur a penalty.
		SKY: YES. RULES EQUIVALENCE.
		Document is ready for review. Double check triangulation.
		Sheet protection must still be active when submitted, or the SES will be rejected.
		YELLOW: YES. CHECK ADDITIONAL EQUIVALENCIES.
		Some entries require additional tubes or documentation.
		Once these are added, document is ready for review.

BLANK

BLANK

REJECT

EQ

This means "pass"

CHECK

mm

Units

Enter the necessary information on other sheets and make sure there are no blanks.

Select "mm" as the unit and match it with the description in the attached drawing.

Front Hoop (FH)

Attach a drawing that can confirm that the entered values are correct

BLANK **Front Hoop (FH), Steering Protection**

F.5.7.2-3 The FH runs from the lowest frame member on each side. The FH may be multiple pie
F.5.6.2.b Front view FH bends below the Upper SIS must meet a triangulated FBHS or SIS nod
F.5.6.2 All FH side view bends must meet a triangulated FBHS or SIS tube end.

BLANK					
F.5.7	**Front Hoop (FH)**	**Minimum**	**Tube Used**		EQ
F.3.2.1.c	Example: 25mm x 2.5mm round	Size A			BLANK
F.3.4.1.a	Wall thickness:	2		mm	BLANK
	Square side:	25		mm	BLANK
	Wall thickness:	2.0		mm	BLANK
	Square side:	25.0		mm	BLANK
	Tube cross sectional area (A):	173		mm^2	BLANK
	Tube second moment of inertia (I):	11320		mm^4	BLANK

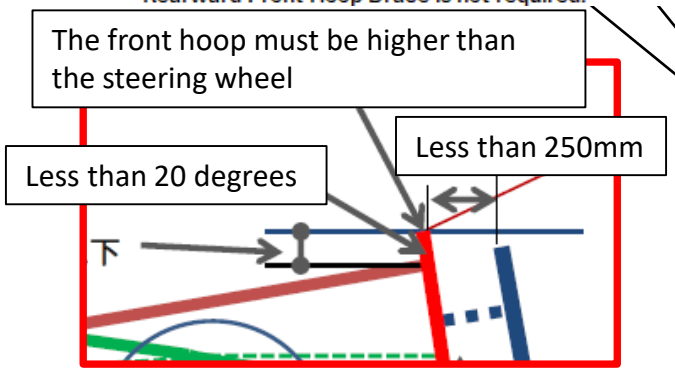
BLANK				
F.5.7.4	Turned Steering Wheel minimum below FH top:		mm	BLANK

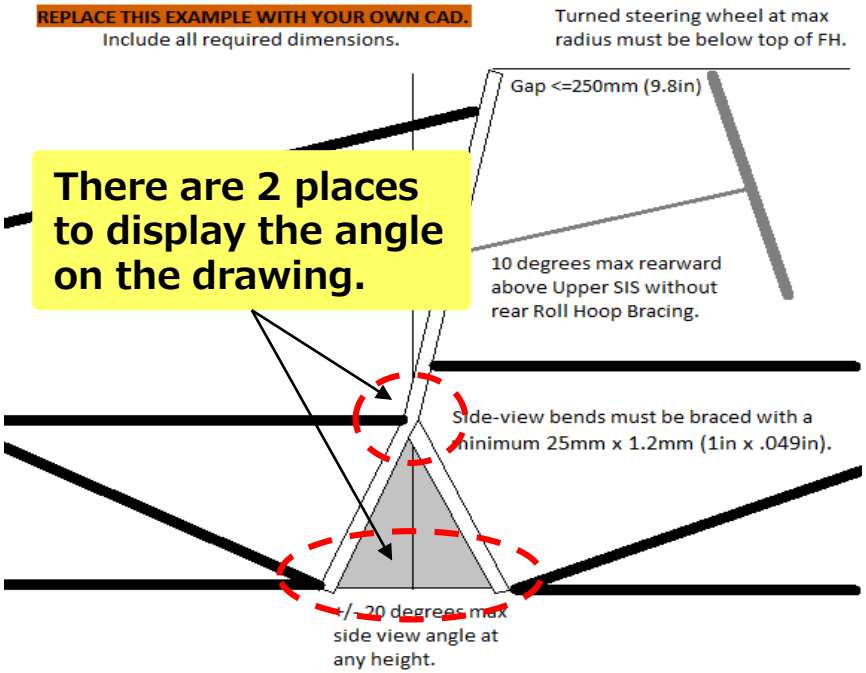
BLANK				
F.5.7.5	FH to Steering Wheel gap <=250mm (9.8in)		mm	BLANK

BLANK				
F.5.7.6	FH side angle above Upper SIS <=20 degrees:		degrees	BLANK

BLANK				
F.6.3.5	FH rearward lean above Upper SIS <= 10, or braced:		degrees	BLANK

Rearward Front Hoop Brace is not required.





There are 2 places to display the angle on the drawing.

・250mm or less is the distance between the rear end of FH and the front side of the steering wheel.
・Since the angle of FH is described in two places, even if the angle is the same, it is necessary to display the drawing in two places.

Appropriately describe these and attach a drawing that can confirm that the values entered in each cell are correct.

Front Hoop (FH) Main Hoop(MH)

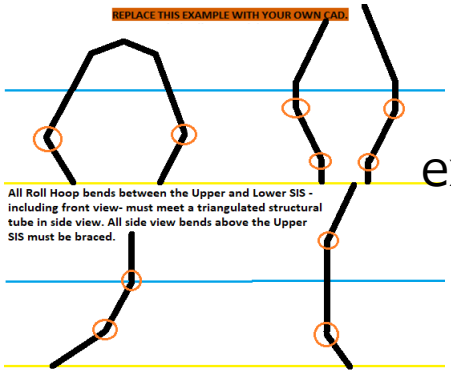
New in 2023

BLANK Front Hoop (FH), Steering Protection

F.5.7.2-3 The FH runs from the lowest frame member on each side. The FH may be multiple pie
F.5.6.2.b Front view FH bends below the Upper SIS must meet a triangulated FBHS or SIS nod
F.5.6.2 All FH side view bends must meet a triangulated FBHS or SIS tube end.

BLANK Main Hoop (MH), Shoulder Harness Bar (SH)

F.5.8.1-2 The Main Hoop extend, uncut, from the lowest frame member on both sides
F.5.6.2 All bends below the Upper SIS must have an SIS or MHBS tube within 25mm.
F.5.8.3.b Main Hoop side view bends must be braced to an MHBS or SIS node.



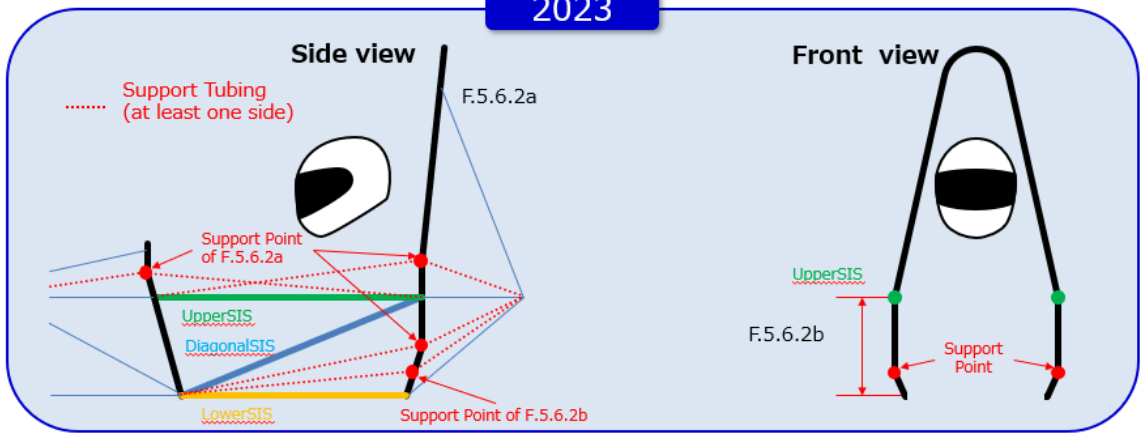
explanation →

2023 Rules Revision

F.5.6.2 Support tubing for Roll Hoop bends Required

The Main Hoop and Front Hoop must be Triangulated into the Primary Structure with structural tubing.
The Triangulation must be at a node in side view for:
a. Bends in side view
b. Bends in front view below the Upper Side Impact Structure F.6.4, F.7.5

Also applicable to monocoque !



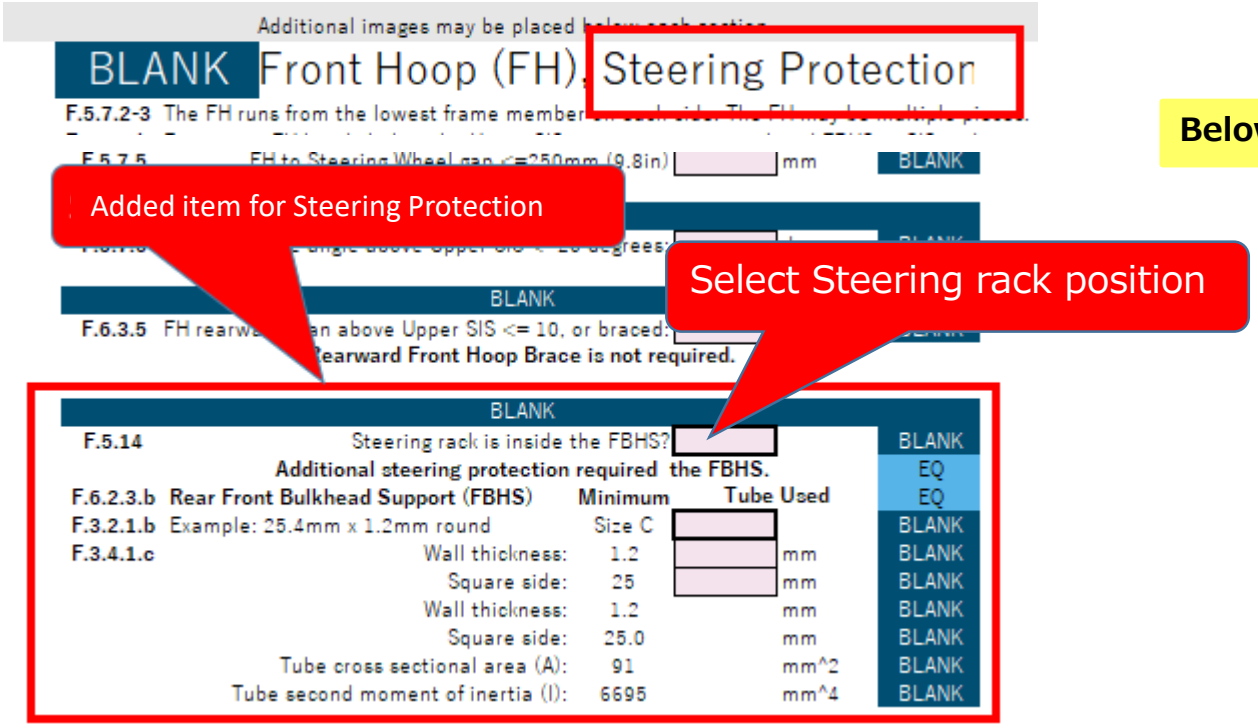
4

・The conformance of F.5.6.2 will be reviewed with the frame diagram attached to the SES. (There is no item to enter a value in a cell in SES)

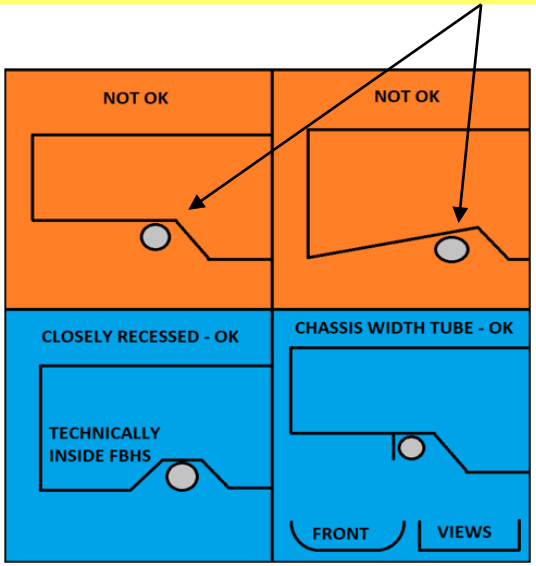
Steering Protection

New in 2023

Attach a drawing that can confirm that the entered values are correct



Below example. Protection is required.

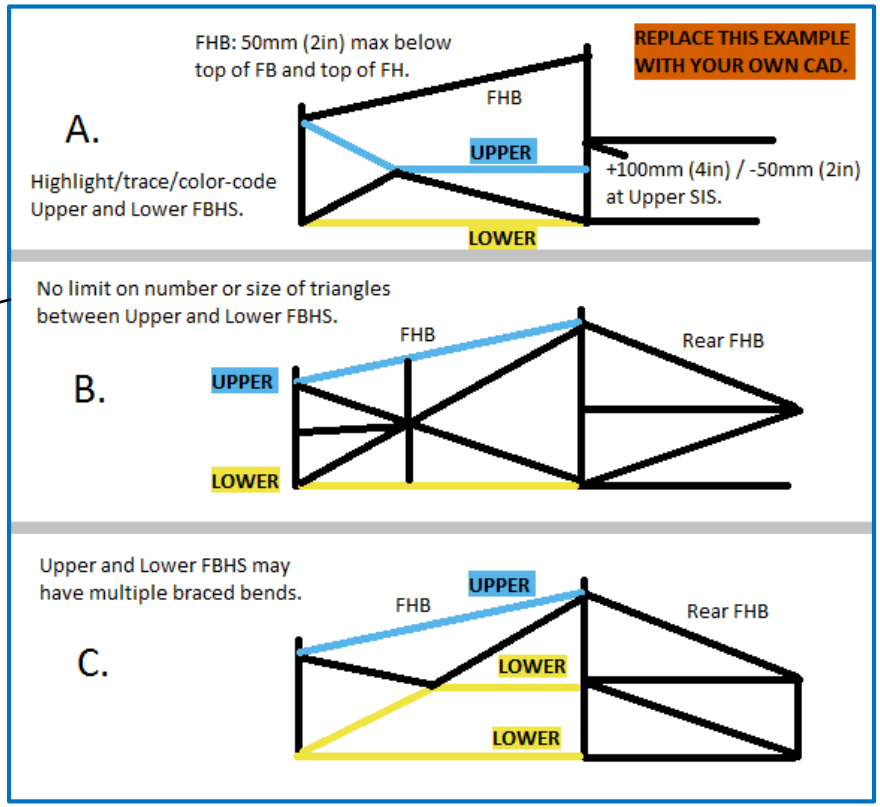


・Choose where the steering rack is mounted relative to the FBHS. (inside, above, below)
・Protection is required for above and below. Enter the pipe shape, size, etc., and attach evidence and drawings showing it.
・In the case of inside, evidence attachment is not required.

Front Bulkhead Supports (FBHS), Front Hoop Braces (FHB)

Attach a drawing that can confirm that the entered values are correct

BLANK					
F.6.2	**Front Bulkhead Support (FBHS)**	**Minimum**	**Tube Used**		EQ
F.3.2.1.b	Example: 25.4mm x 1.2mm round	Size C	Round		EQ
F.3.4.1.c	Wall thickness:	1.2		mm	BLANK
	Outer Diameter (OD):	25		mm	BLANK
	Wall thickness:	1.2		mm	BLANK
	Outer Diameter (OD):	25.0		mm	BLANK
	Tube cross sectional area (A):	91		mm^2	BLANK
	Tube second moment of inertia (I):	6695		mm^4	BLANK
BLANK					
F.6.2.3.a	Top of FB to Upper FBHS tube, 50mm vertical limit:			mm	BLANK
BLANK					
F.6.2.3.ab	FBHS configuration:		A		EQ
	Top of Upper FBHS tube relative to top of Upper SIS tube:		Above		EQ
	Without Rear FHB, vertical limit 100mm above:			mm	BLANK
	Rearward Front Hoop Brace is not required.				
BLANK					
F.6.3.4	Top of FH to top of FHB tube, 50mm vertical limit:			mm	BLANK
BLANK					
F.6.3	**Forward Front Hoop Braces (FHB)**	**Minimum**	**Tube Used**		EQ
F.3.2.1.d	Example: 25.4mm x 1.6mm round	Size B	Round		EQ
F.3.4.1.b	Wall thickness:	1.2		mm	BLANK
	Outer Diameter (OD):	25		mm	BLANK
	Wall thickness:	1.2		mm	BLANK
	Outer Diameter (OD):	25.0		mm	BLANK
	Tube cross sectional area (A):	114		mm^2	BLANK
	Tube second moment of inertia (I):	8509		mm^4	BLANK
	Rearward Front Hoop Brace is not required.				
EQ					
F.6.2.3.b	**Rear Front Bulkhead Support (FBHS)**	**Minimum**	**Tube Used**		N/A
F.3.2.1.b	Example: 25.4mm x 1.2mm round	Size C	Round		N/A
F.3.4.1.c	Wall thickness:	1.2		mm	N/A
	Outer Diameter (OD):	25		mm	N/A
	Wall thickness:	1.2		mm	N/A
	Outer Diameter (OD):	25.0		mm	N/A
	Tube cross sectional area (A):	91		mm^2	N/A
	Tube second moment of inertia (I):	6695		mm^4	N/A



There are many mistakes.
Choose a pattern (A, B, C) that suits your team's structure from the above.

A : FHB and FBHS Upper are independent
B/C: FBHS Upper is shared with FHB
In addition, a Rear FHB is required!

Side Impact Structure (SIS)

Attach a drawing that can confirm that the entered values are correct

		EQ				
F.6.4.4.b	F.6.4.1 Upper Side Impact Structure (SIS)			Straight		EQ
F.6.4.4.b			Minimum	Tube Used		EQ
	F.3.2.1.e Example: 25.4mm x 1.6mm round		Size B	Round		EQ
	F.3.4.1.b	Wall thickness:	1.2	1.2	mm	EQ
		Outer Diameter (OD):	25	35	mm	EQ
		Wall thickness:	1.2	1.2	mm	EQ
		Outer Diameter (OD):	25.0	35.0	mm	EQ
		Tube cross sectional area (A):	114	127	mm^2	EQ
		Tube second moment of inertia (I):	8509	18220	mm^4	EQ
		BLANK				
		Top surface of Lower SIS to Lowest UpperSIS point >=240mm			mm	BLANK
		Top surface of Lower SIS to Highest UpperSIS point <=320mm			mm	BLANK
		Highest and lowest are on the top and bottom of the Upper SIS tube		0	mm	BLANK
ructure.						
		BLANK				
	F.6.4.1 Lower and Diagonal SIS		Minimum	Tube Used		EQ
	F.3.2.1.e Example: 25.4mm x 1.6mm round		Size B	Round		EQ
	F.3.4.1.b	Wall thickness:	1.2		mm	BLANK
		Outer Diameter (OD):	25		mm	BLANK
		Wall thickness:	1.2		mm	BLANK
		Outer Diameter (OD):	25.0		mm	BLANK
		Tube cross sectional area (A):	114		mm^2	BLANK
		Tube second moment of inertia (I):	8509		mm^4	BLANK

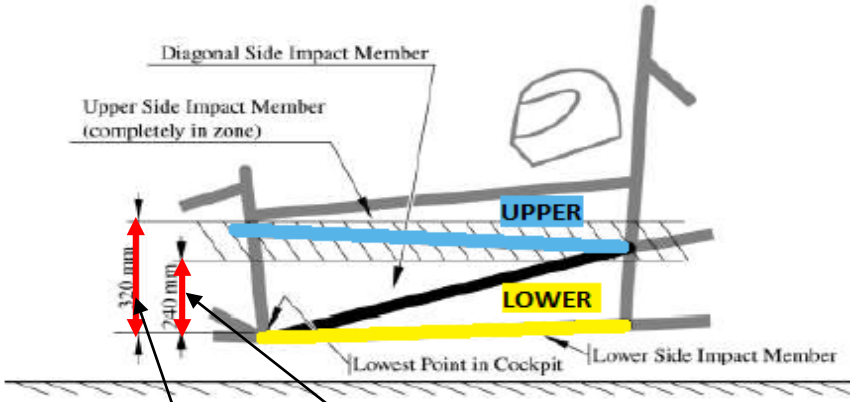
T.2.4.2 F.3.2.1.j Lap and sub belts attachments must be located on minim

REPLACE THIS EXAMPLE WITH YOUR OWN CAD.

Include all required dimensions.

Highlight/trace/color code Upper and Lower SIS.

Bent Upper SIS must use larger tube whether bent in top or side view.



240mm

320mm

There are many mistakes in this section distance

・The distance between the lowest point of the cockpit and the lowest point of Upper SIS

・The distance between the lowest point of the cockpit and the highest point of Upper SIS

Appropriately specify these and attach a drawing that can confirm that the values entered in each cell below are correct.

Lap and Sub Belt Attachment

Attach a drawing that can confirm that the entered values are correct

BLANK					
T.2.4.2	F.3.2.1.j	Minimum Lap/Sub Belt Tube	Minimum	Tube Used	EQ
F.3.2.1.j	Example: 25.4mm x 1.6mm round		Size B		BLANK
F.3.4.1.b		Wall thickness:	1.2	mm	BLANK
		Square side:	25	mm	BLANK
		Wall thickness:	1.2	mm	BLANK
		Square side:	25.0	mm	BLANK
		Tube cross sectional area (A):	114	mm^2	BLANK
		Tube second moment of inertia (I):	8509	mm^4	BLANK

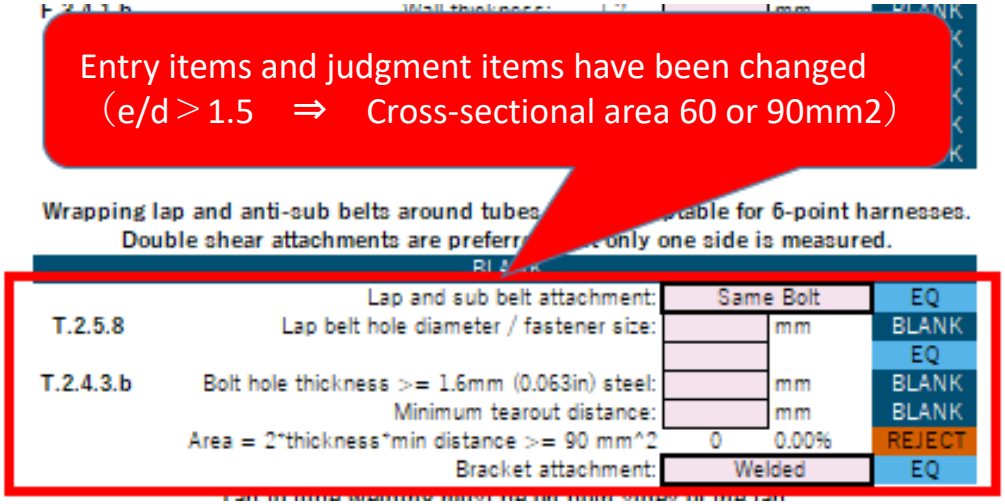
Wrapping lap and anti-sub belts around tubes is not acceptable for 6-point harnesses.
Double shear attachments are preferred, but only one side is measured.

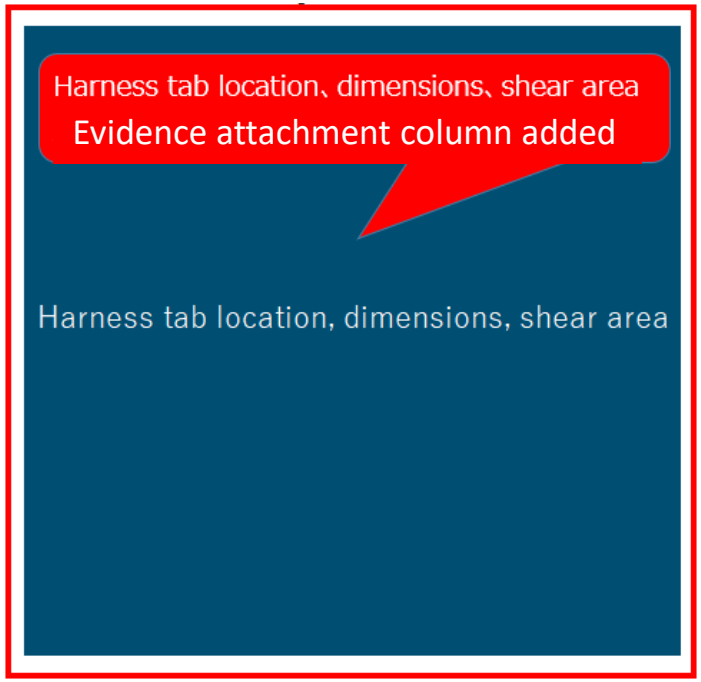
Enter the minimum side of the pipe to attach Lap or Sub Belt

Lap and Sub Belt Attachment

2023 change

Attach a drawing that can confirm that the entered values are correct





・Attachment judgment changed from e/d to cross-sectional area judgment
・Please note that the judgment value of the cross-sectional area is different when Same Bolt is selected and when Individual Bolt is selected.
- Evidence attachment column added
⇒ No matter what kind of attachment you choose, attach provable evidence.
・However, <u>if the I-BOLT is cut and welded directly to the frame, this item will be excluded from the examination.</u>
No need to enter numerical values. It does not matter if it becomes BLANK or REJECT.
In the evidence attachment column, please include a comment stating that "I-BOLT will be cut and welded".

Main Hoop (MH), Shoulder Harness Bar (SH)

Attach a drawing that can confirm that the entered values are correct

BLANK					
F.5.8.1	**Main Hoop (MH)**	**Minimum**	**Tube Used**		EQ
F.3.2.1.g	Example: 25mm x 2.5mm round	Size A	Round		EQ
F.3.4.1.a	Wall thickness:	2		mm	BLANK
	Outer Diameter (OD):	25		mm	BLANK
	Wall thickness:	2.0		mm	BLANK
	Outer Diameter (OD):	25.0		mm	BLANK
	Tube cross sectional area (A):	173		mm^2	BLANK
	Tube second moment of inertia (I):	11320		mm^4	BLANK

BLANK					
F.6.5	**Shoulder Harness Bar (SH)**		Straight		EQ
		Minimum	**Tube Used**		EQ
F.3.2.1.k	Example: 25mm x 2.5mm round	Size A	Round		EQ
F.3.4.1.a	Wall thickness:	2		mm	BLANK
	Outer Diameter (OD):	25		mm	BLANK
	Wall thickness:	2.0		mm	BLANK
	Outer Diameter (OD):	25.0		mm	BLANK
	Tube cross sectional area (A):	173		mm^2	BLANK
	Tube second moment of inertia (I):	11320		mm^4	BLANK

Shoulder Harness Bar does not require braces.

EQ				
F.6.5.2.b	Brace angle to plane of SH side view >= 30:		degrees	N/A

F.5.2.3 The plane of a bent tube is defined by the straight axes on either side of the bend.

Shoulder Harness Bar does not require braces.

EQ					
F.6.5.1	**Shoulder Harness Braces**	**Minimum**	**Tube Used**		N/A
F.3.2.1.l	Example: 25.4mm x 1.2mm round	Size C	Round		N/A
F.3.4.1.c	Wall thickness:	1.2		mm	N/A
	Outer Diameter (OD):	25		mm	N/A
	Wall thickness:	1.2		mm	N/A
	Outer Diameter (OD):	25.0		mm	N/A
	Tube cross sectional area (A):	91			
	Tube second moment of inertia (I):	6695			

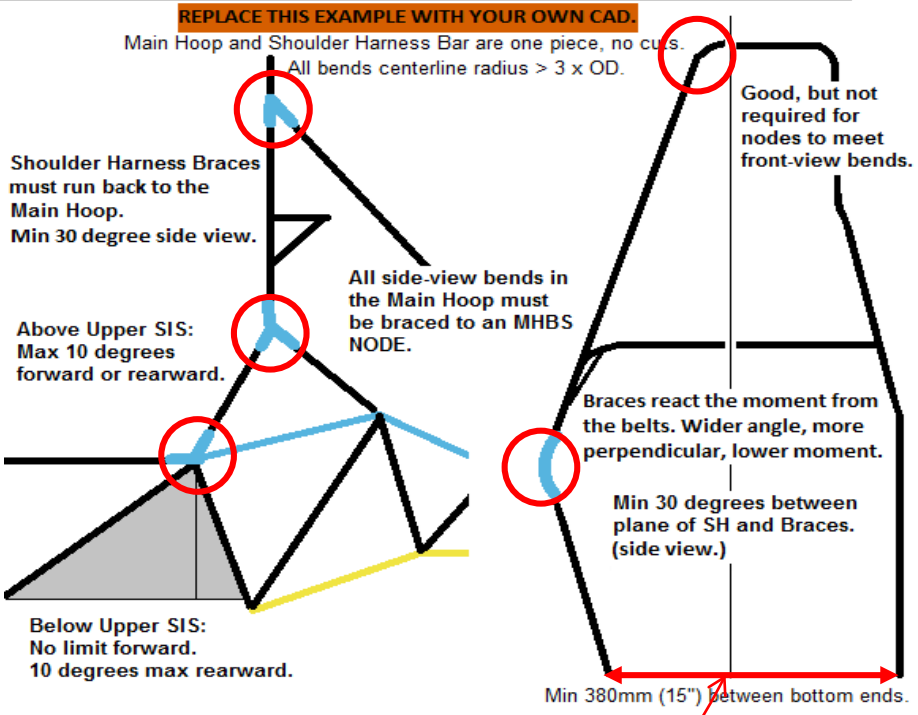
BLANK			
F.5.8.3.a	Main Hoop direction above Upper SIS, in side view:	Verti	
	in Hoop angle from vertical above Upper SIS, in side view, <=10:		
F.5.8.2	**Main Hoop Braces may run forward or rearwa**		

BLANK			
F.5.8.3.c	Main Hoop direction below Upper SIS, in side view:	Verti	
	Main Hoop side angle from vertical below Upper SIS:		

BLANK			
F.5.8.4	Distance between Main Hoop ends, >=380mm (15")		

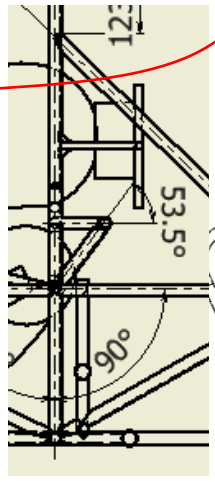
F.5.2.1 **E**nter the tightest bend on any **T.5-6** tube in the chassis (usually in the MH or SH.)

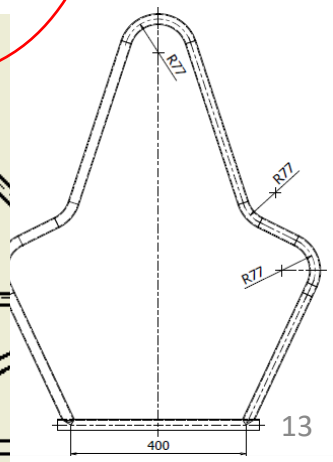
BLANK				
F.5.2.1	Minimum tube centerline radius:		mm	BLANK
	Outer Diameter (OD):		mm	BLANK
	Minimum radius::diameter ratio, >=3:			



- **Angle of MH**
- **Distance between ends of MH lower end**
- **Bend R (all bent points)**
- **If SH is a Bend Tube,**
  Brace angle seen from the side

(The figure on the right is an example)

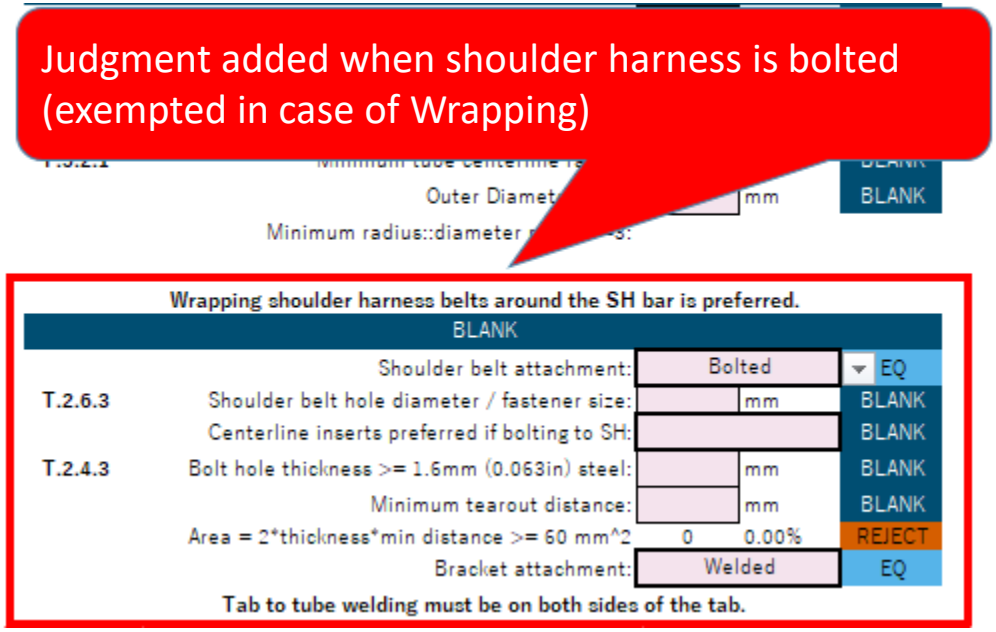




Shoulder Harness Bar（Attachment）

Added in 2023

Attach a drawing that can confirm that the entered values are correct



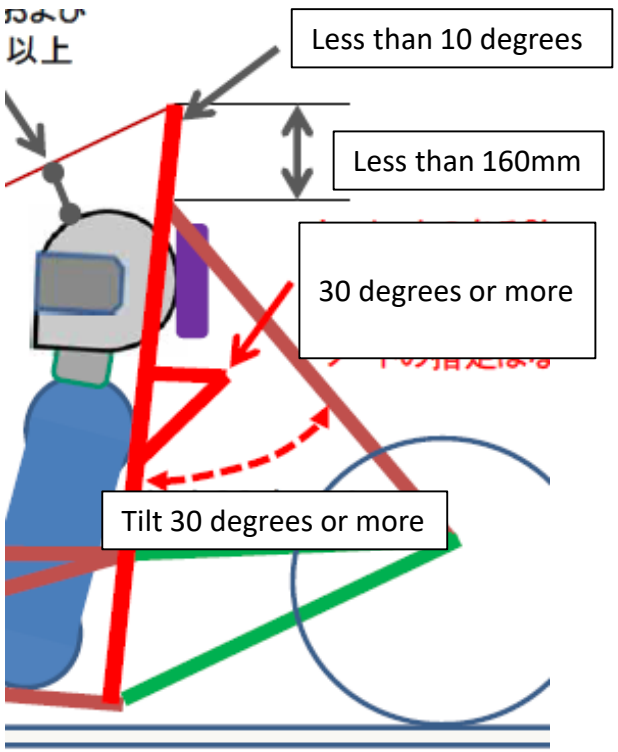
・In the case of bolt fastening, enter each item and attach the evidence to prove it.
・If Wrapping is selected, enter "N/A" below and no input is required.
・<u>If the I-BOLT is cut and welded directly to the frame, this item will be excluded from the review.</u>
No need to enter numerical values. It does not matter if it becomes BLANK or REJECT.
　Use the text box to add a comment to the effect that "I-BOLT will be cut and welded".

Main Hoop Braces (MHB), Main Hoop Brace Supports (MHBS)

Attach a drawing that can confirm that the entered values are correct

Main Hoop Braces may run forward or rearward.

	BLANK			
F.5.9.2	Main Hoop brace direction:	Rearward		EQ
F.5.9.5	Angle between MH and MHB >=30 degrees:		degrees	BLANK
	BLANK			
F.5.9.4	Top of MH of MHB tube, 160mm vertical limit:		mm	BLANK
	BLANK			
F.5.9.1	**Main Hoop Brace (MHB)**	**Minimum**	**Tube Used**	EQ
F.3.2.1.h	Example: 25.4mm x 1.6mm round	Size B	Round	EQ
F.3.4.1.b	Wall thickness:	1.2	mm	BLANK
	Outer Diameter (OD):	25	mm	BLANK
	Wall thickness:	1.2	mm	BLANK
	Outer Diameter (OD):	25.0	mm	BLANK
	Tube cross sectional area (A):	114	mm^2	BLANK
	Tube second moment of inertia (I):	8509	mm^4	BLANK
	BLANK			
F.6.6	**Main Hoop Brace Support (MHBS)**	**Minimum**	**Tube Used**	EQ
F.3.2.1.i	Example: 25.4mm x 1.2mm round	Size C	Round	EQ
F.3.4.1.c	Wall thickness:	1.2	mm	BLANK
	Outer Diameter (OD):	25	mm	BLANK
	Wall thickness:	1.2	mm	BLANK
	Outer Diameter (OD):	25.0	mm	BLANK
	Tube cross sectional area (A):	91	mm^2	BLANK
	Tube second moment of inertia (I):	6695	mm^4	BLANK



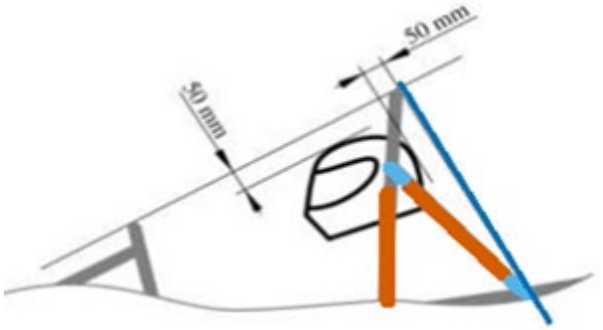
・Angle between MH and MHB
・Distance between MH vertex and MHB connection point

Appropriately specify these and attach a drawing that can confirm that the values entered in each cell below are correct.

Helmet Clearance

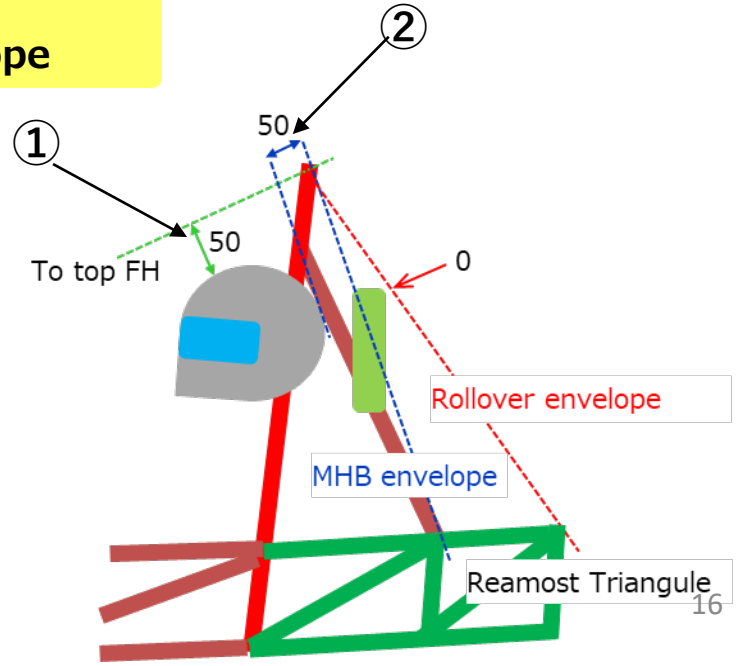
Attach a drawing that can confirm that the entered values are correct

BLANK				
F.5.6.3.a	Helmet >=50mm (2in) below Roll Hoop plane:		mm	BLANK ①
BLANK				
F.5.6.3.bc	Main Hoop Braces protecting Helmet:	Rearward		EQ
F.5.6.3.bc	Helmet >=50mm (2in) below MH to bottom of MHB:		mm	BLANK ②



① Clearance between the line connecting the MH vertex and the FH vertex and the helmet

② Clearance behind helmet for MH apex and MHB envelope



Fuel System (IC) other

2023 change

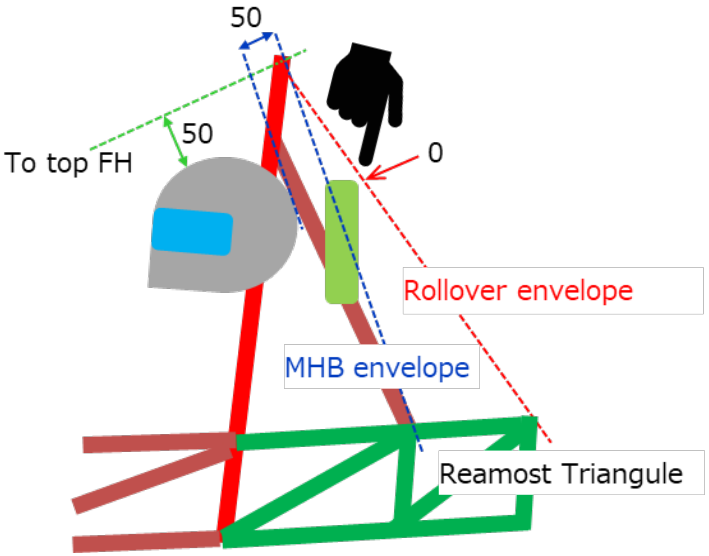
BLANK			
Fuel system inside tire envelope?		IC.1.2	BLANK
Fuel system above bottom surface of chassis?		F.9.1	BLANK
Fuel system including fill tube inside triangulated structure below 350mm?		F.9.1.1.	BLANK
Any pressure tanks are metal or separated from exhaust by T.1.6.3?		T.6.1.3	BLANK
2 holes, chassis low point? 2 holes between driver & fuel tank? >25mm?		T.5.5.4	BLANK

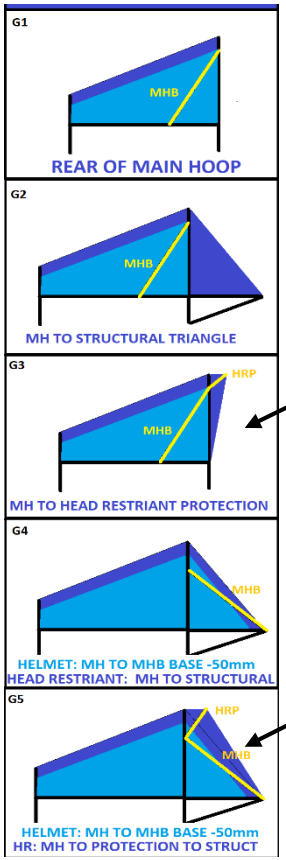
Questionnaire items Added 2 items
· Thermal protection from the exhaust system of high-pressure gas cylinders
· System sealing; 25mm diameter holes x 2 locations

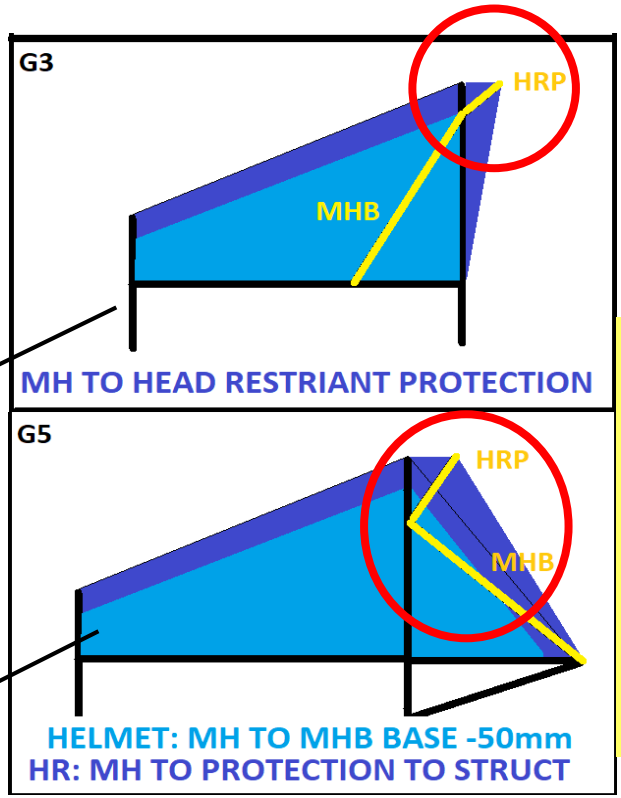
・Select Yes or No for all items.
・Assuming that the detailed design of the fuel tank and high-pressure gas cylinder cannot be completed at the time of SES creation,
<u>These five interview items are excluded from the examination items for SES.</u>
However, it will be strictly examined during the actual on-site vehicle inspection.

Head Restraint

	BLANK				
T.2.8.4	Head Restraint >=0 from rollover envelope:			mm	BLANK
F.5.10	**Head Restraint Protection Hoop Used?**		Select Drop Down:		BLANK
F.3.2.1.h	Example: 25.4mm x 1.6mm round	Size B	Round		N/A
F.3.4.1.b	Wall thickness:	1.2		mm	N/A
	Outer Diameter (OD):	25		mm	N/A
	Wall thickness:	1.2		mm	N/A
	Outer Diameter (OD):	25.0		mm	N/A
	Tube cross sectional area (A):	114		mm^2	N/A
	Tube second moment of inertia (I):	8509		mm^4	N/A





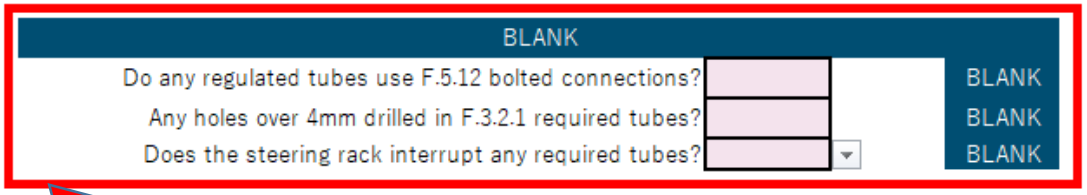


Additional measures if the Head Restraint protrudes from the Rollover envelope

"Head Restraint Protection" is written to the right of "SES".
If the F.1.13 rollover protection connected from the Main Hoop is not established as in the examples of G3 and G5, it is possible to add HRP (Head Restraint Protection) as circled in red in the left figure.

Other

New in 2023

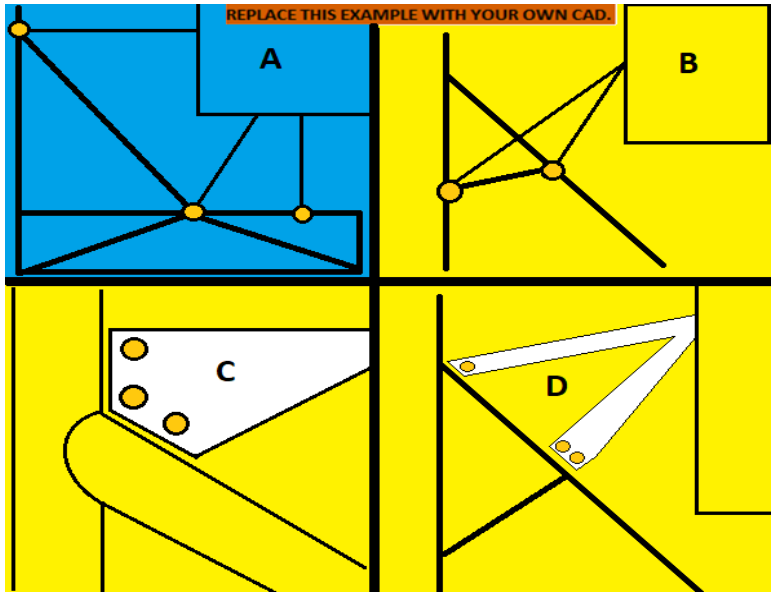


Questionnaire items 3 additions
・Removable MHB using Bolted Member
・Welded Tube Insert request when a hole of 4mm or more is made in the frame
・Steering rack interruption using Welded Tube Insert

・Select Yes or No for all items.
・If you select YES, it will be automatically determined that you will be asked to enter information on the "Welded Tube Insert" or "Bolted Members" sheets in SES, so enter the necessary information on each sheet.

Rear Wing Mounting

	BLANK				
F.5.11	Rear Wing chassis mounting locations:	Select drop down:			BLANK
	Number of fasteners per wing mount, chassis side:				N/A
F.5.11.2.b	**Wing Mount Braces**	**Minimum**	**Tube Used**		N/A
F.3.2.1.o	Example: 25.4mm x 1.2mm round	Size C	Round		N/A
F.3.4.1.c	Wall thickness:	1.2		mm	N/A
	Outer Diameter (OD):	25		mm	N/A
	Wall thickness:	1.2		mm	N/A
	Outer Diameter (OD):	25.0		mm	N/A
	Tube cross sectional area (A):	91		mm^2	N/A
	Tube second moment of inertia (I):	6695		mm^4	N/A
F.5.11.2.b	**Calculation of buckling strength of MHB tube.**				N/A
F.3.4.2	Yield Strength (Sy):	3.05E+08		Pa	N/A
	Main Hoop Brace Outer Diameter (OD):	0		mm	N/A
	Main Hoop Brace second moment of inertia (I):			mm^4	N/A
	Main Hoop Brace Length (Main Hoop to MHBS) (L):			mm	N/A
	Wing Mount distance to closest MHB end (a):			mm	N/A
	MHB Max Moment Load (Sy*L*I)/(a*(L-a)*OD/2):			N	N/A
	Failure mechanism:	Select drop down:			N/A
				lbs	N/A
		0			N/A



A **STRONGLY PREFERRED**
Single fastener at each node, rotationally free.
No failure force required.
Mounts rearward of the MHB assembly are completely unrestricted

B **NOT RECOMMENEDED**
Mounts in the middle of the MHB or MH require a brace between the two.
All fasteners or mounts on a side must fail simultaneously below the MHB buckling force.

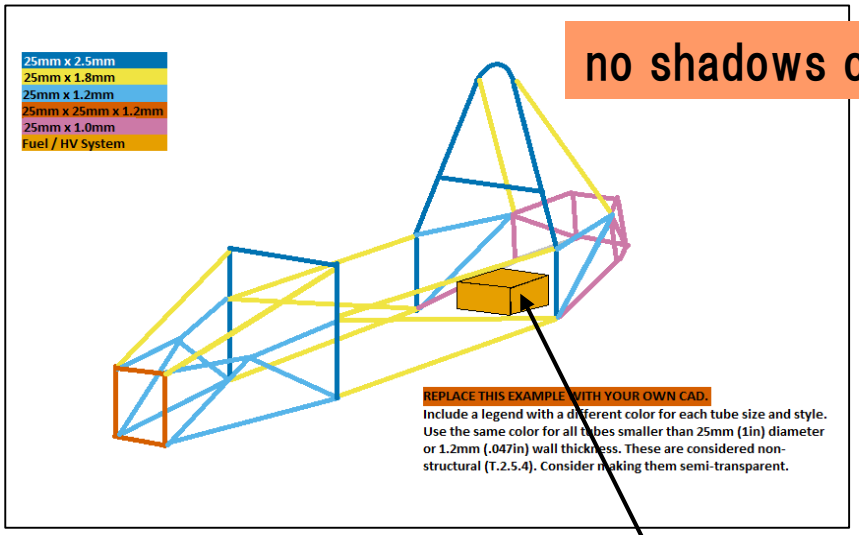
C **NOT RECOMMENEDED - GUSSET MAY BE REQUIRED**
Multiple fasteners within 1x outer diameter of the node.
All but one fastener must fail simultaneously below the MHB buckling force.

D **NOT RECOMMENEDED**
Multiple fasteners along the MHB.
Brace required between MH and MHB at rearmost fastener.
All fasteners not located at the MH-MHB node must fail simultaneously below the MHB buckling force.

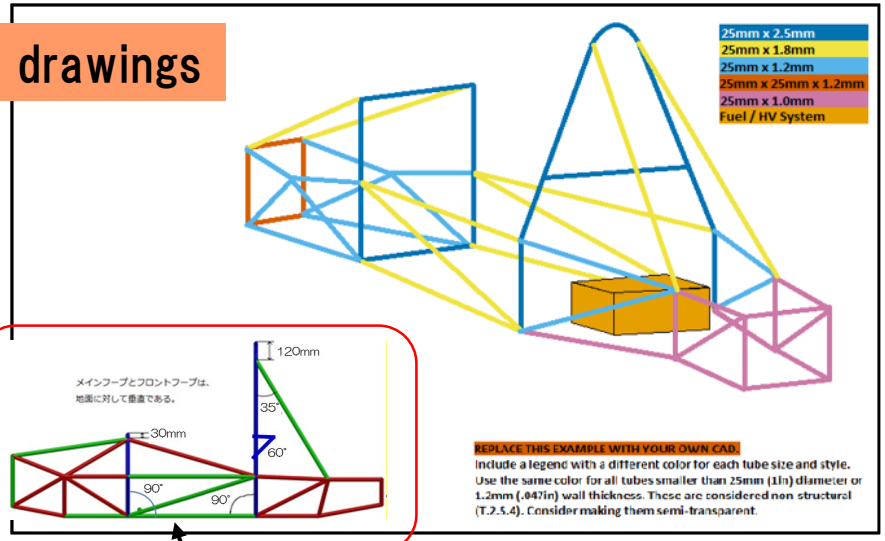
Type-A is strongly recommended for Rear Wing fixing method.
If your team is Type-B/C/D, read each comment carefully and respond accordingly.
Insufficient mounting methods are not permitted.

Front & Rear 3/4 3D CAD

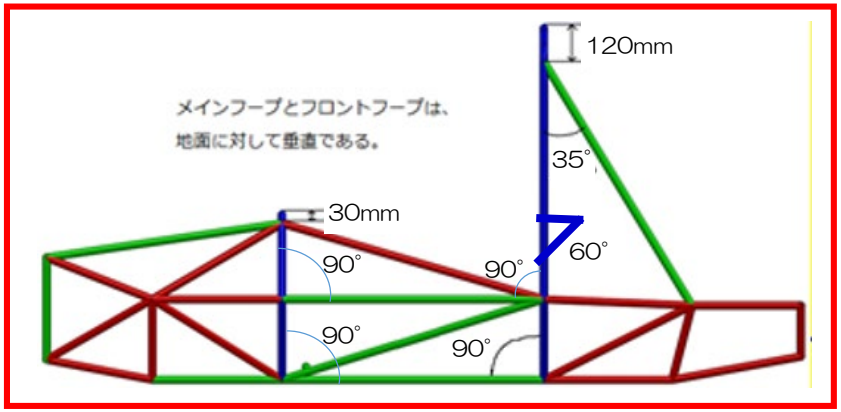
Enter the front and rear sides of the isometric drawing as shown below.



no shadows on drawings



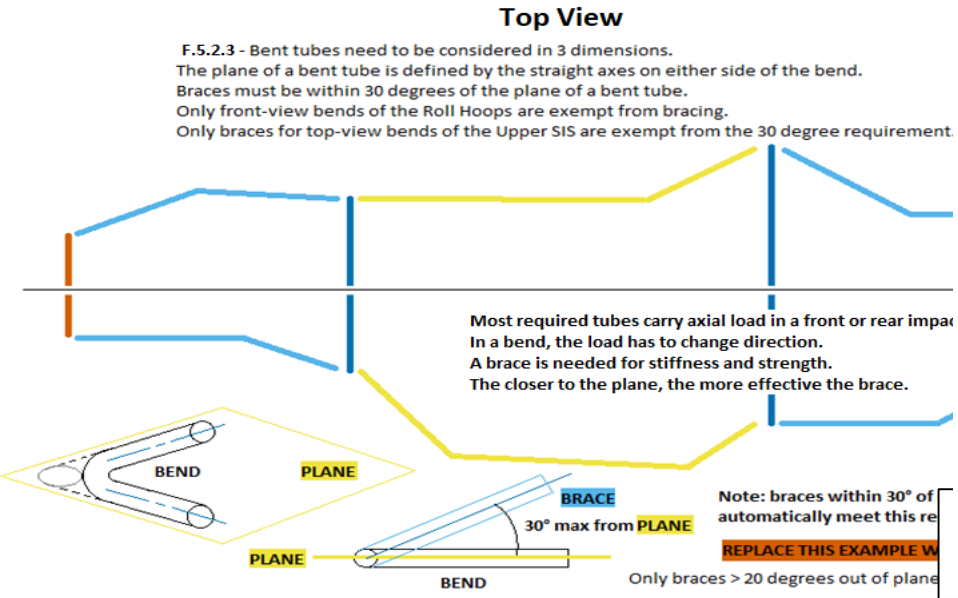
1. Three-view drawing not required
2. Illustrate the fuel tank for ICVs and the Accumulator Container for EVs
3. It is recommended that the color coding of the pipe is the same as the sample.
4. All pipes with an outer diameter of 25 mm or a wall thickness of 1.2 mm or less shall be of the same color.

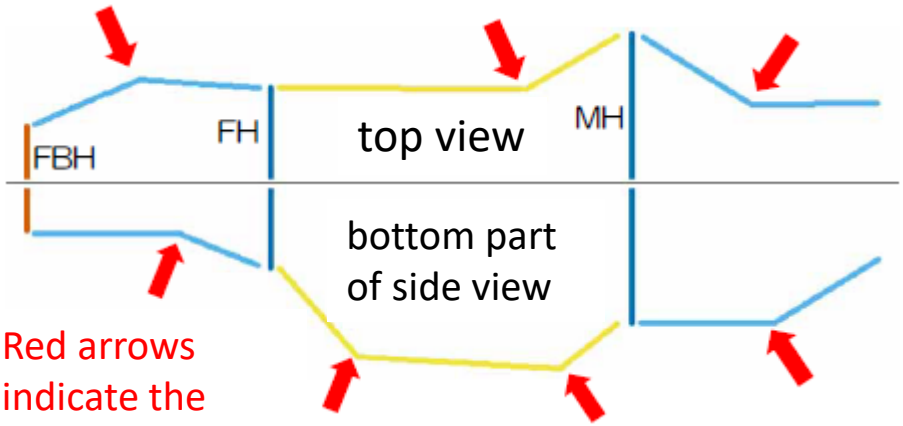


Please add a side view showing the size of each part as shown above
(To facilitate the examination)

Bent Tubes

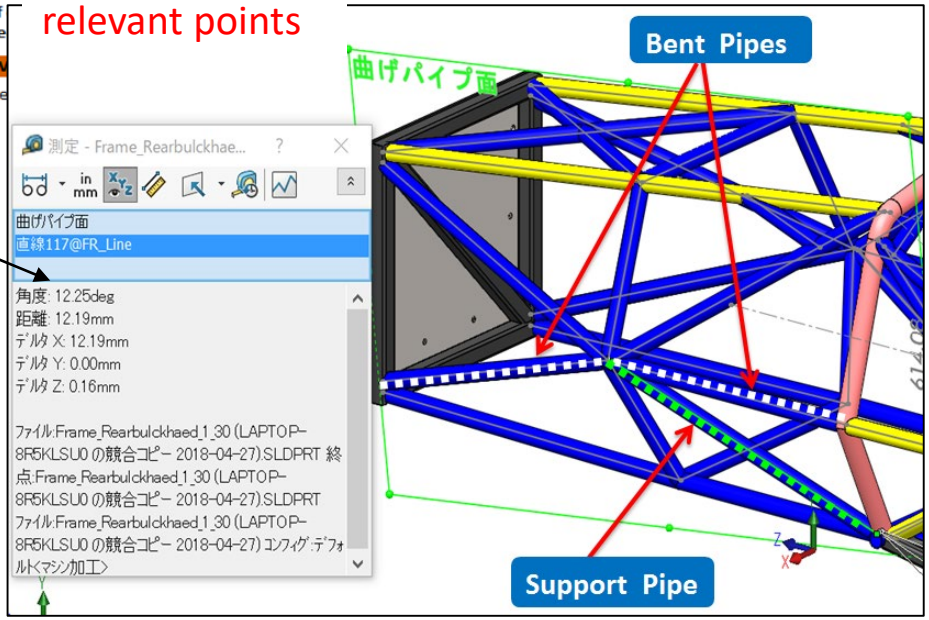
For the bent pipe of the frame, certify that "the angle between the plane formed by the bent pipe and the brace is 30 degrees or less."
You must attach the target part and all diagrams.





Red arrows indicate the relevant points

An example to prove 30 degrees or less. Calculate the angle with 3D-CAD and attach the result.



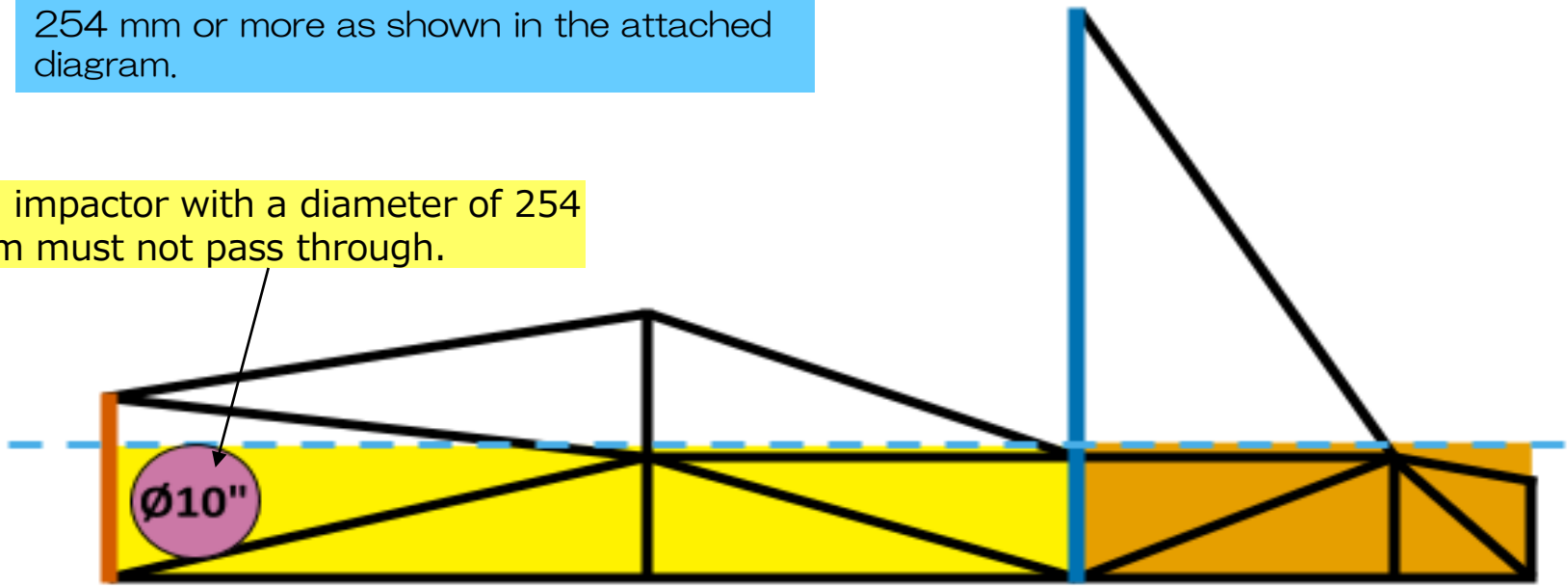
A bent pipe is not only a pipe that is bent like a bow, but also a pipe that is made by joining a plurality of straight pipes together.

GR.1.4 - Good Engineering Practice

If the frame opening is large, do an impactor check.
(Must be proved by illustration)

This rule applies only when there is an open space below Upper SIS with a diameter of 254 mm or more as shown in the attached diagram.

An impactor with a diameter of 254 mm must not pass through.



No openings in the region below upper SIS height between the front bulkhead and main roll hoop, or between any tubes used for Fuel, HV, or component protection may allow a 254mm (10in) diameter impactor to pass through.

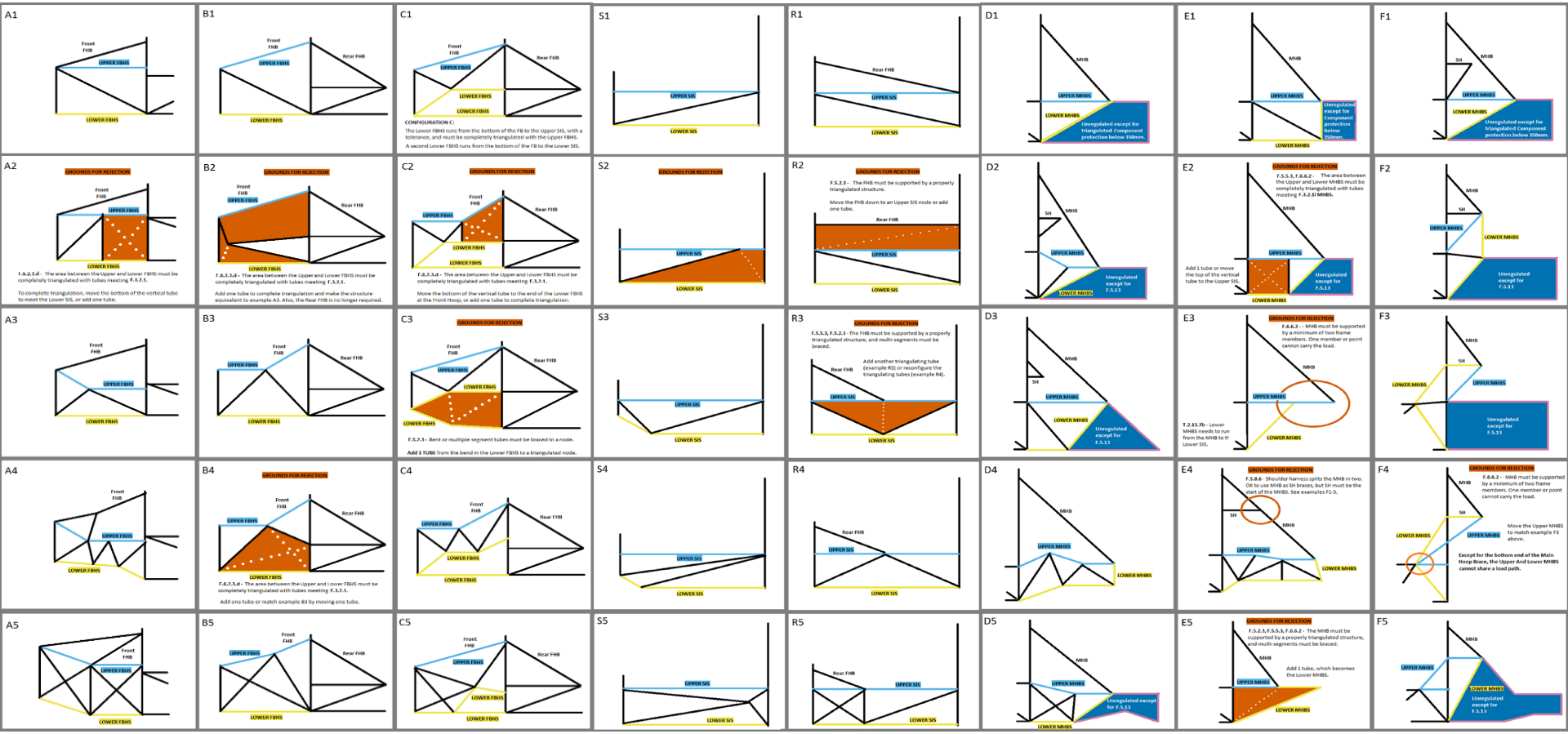
The impactor will be held vertically and seek to intrude into the frame horizontally between the ground and the maximum upper SIS height per rule F.6.4.4.

The top of the impactor will not be raised above the maximum upper SIS Height per rule F.6.4.4.

Any non-structural tubes per F.3.3 will be ignored.

Frame configuration example

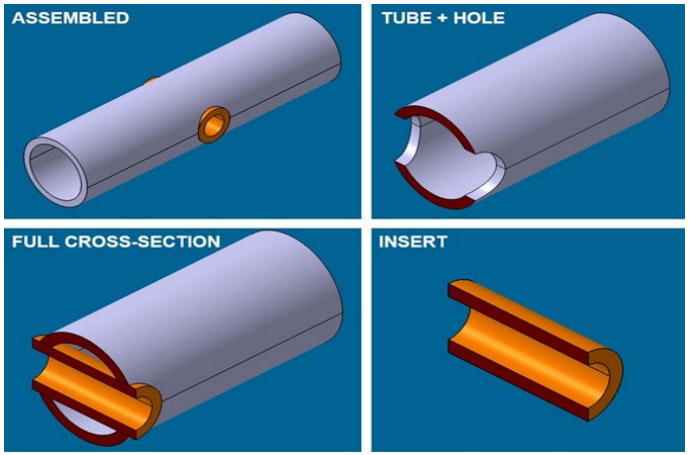
Consider the frame configuration by referring to the examples below (FBHS, SIS, MHBS, SH).

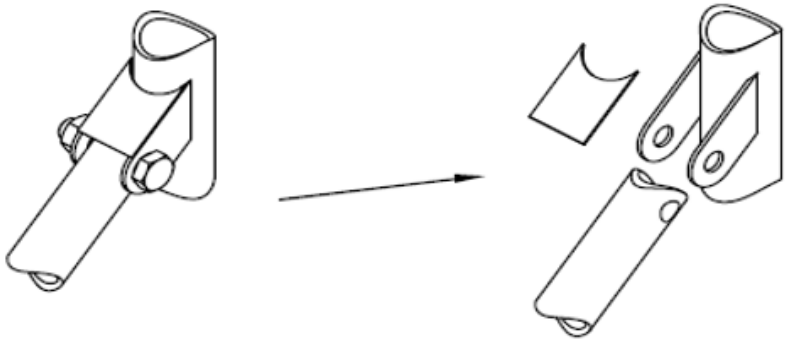


SES
(Structural-Equivalency-Spreadsheet)

F.3.4.3 **Welded Inserts**

F.5.12 **Bolted members**



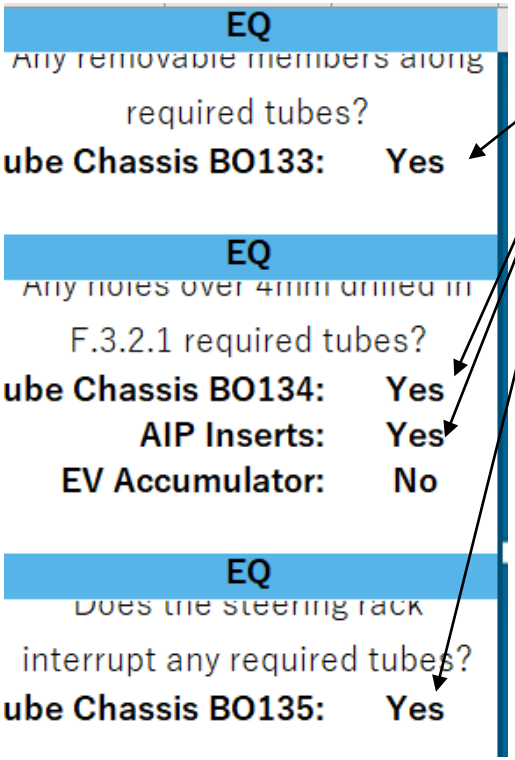


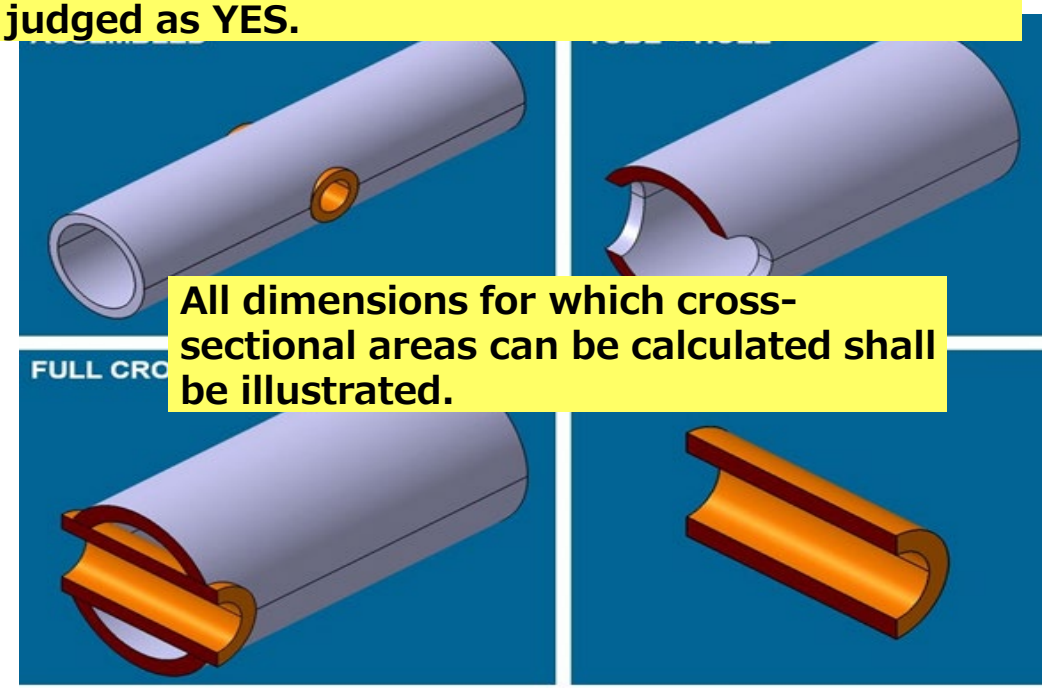
Caution：Welded Tube Insert

The designated parts are the following five places.
・Removable Tube (MHBS)
・ When drilling a hole of 4 mm or more in the standard pipe
・ AIP Insert (when directly bolting AIP to PIPE)
・EV Accumulator
・Steering Rack Pass

To prove that the rigidity of the pipe itself is maintained by the inserted pipe when a hole is made in the pipe of the basic structure and a rod or the like is passed through it.

If applicable, a Yes/No judgment is automatically made based on the input values of other sheets, so prove all parts judged as YES.





All dimensions for which cross-sectional areas can be calculated shall be illustrated.

Welded Tube Insert

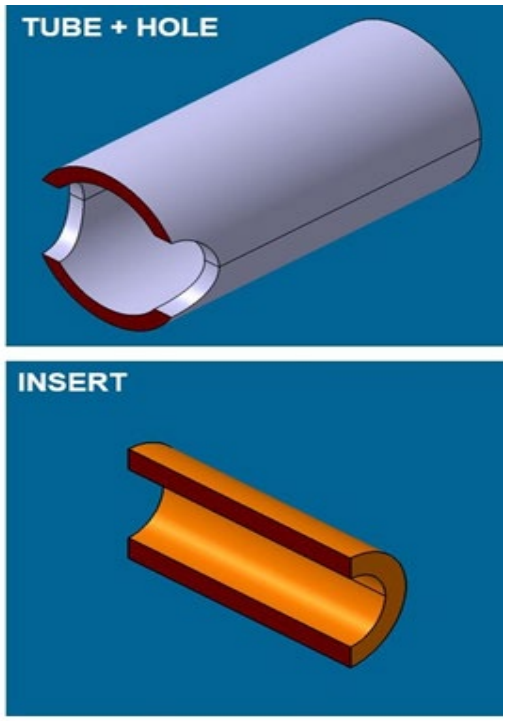
Enter the required items.

If the rigidity is insufficient, "REJECT" will be displayed, so redesign with "EQ" dimensions.

Note: Young's Modulus is given in MPa, not Gpa.

			Minimum F.3.2.1 Tube	Tube With Hole + Insert		
		Material:	Steel	Steel		EQ
		Original tube:	Size A	Round		EQ
F.3.4.1		Wall thickness:	2		mm	BLANK
		Outer Diameter:	25		mm	BLANK
		Tube cross sectional area (A_1):	1.73E+02	-	mm^2	EQ
		Tube second moment of inertia (I_1):	1.13E+04	-	mm^4	EQ
F.3.4.3		Tube with Hole cross sectional area (A_3):			mm^2	BLANK
		Tube with Hole second moment of inertia (I_3):			mm^4	BLANK
		Insert/Collar cross sectional area (A_2):			mm^2	BLANK
		Insert/Collar second moment of inertia (I_2):			mm^4	BLANK
F.3.4.2	F.3.5.3	Young's Modulus (E):	2.00E+11	2.00E+11	Pa	EQ
		Unwelded Yield Strength (Sy):	3.05E+08	3.05E+08	Pa	EQ
		Unwelded Ultimate Strength (Su):	3.65E+08	3.65E+08	Pa	EQ
		Welded Yield Strength (Sy):	N/A	1.80E+08	Pa	EQ
		Welded Ultimate Strength (Su):	N/A	3.00E+08	Pa	EQ
Buckling Modulus		E_1*I_1 <= E_2*I_2 + E_1*I_3:				BLANK
Yield		Sy_1*A_1 <= Sy_2*A_2 + Sy_1*A_3:				BLANK
Ultimate		Su_1*A_1 <= Su_2*A_2 + Su_1*A_3:				BLANK
Bending		I*Su_1*I_1/r <= 4*(Su_2*I_2+Su_1*I_3)/r:				BLANK
Deflection		Bending_1/(48*EI):				BLANK
Energy		0.5*Bending^2/(48*EI):				BLANK

Write down the calculation results of each cross-sectional area and cross-sectional moment of inertia!



Bolted Members

When connecting the Main Hoop Brace with bolts, prove that the rigidity is equal to or greater than that of a single pipe according to the legend below.

There are two connection methods, Double Lug Joint or Sleeved Butt Joint.

REPLACE THIS EXAMPLE WITH YOUR OWN CAD

Figure – Double Lug Joint

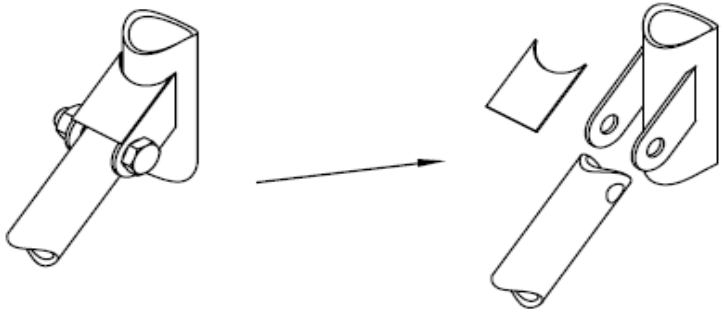
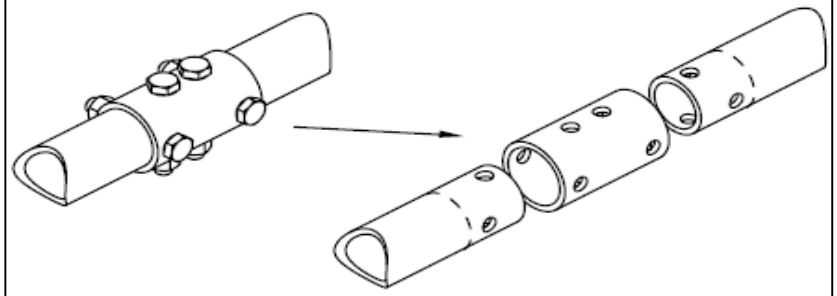
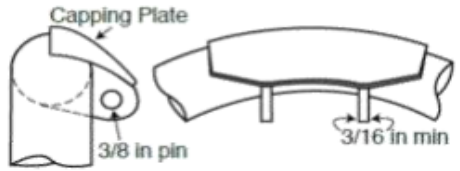


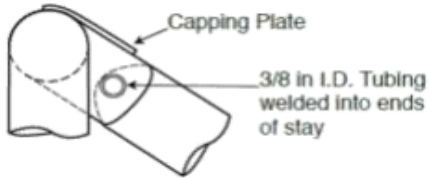
Figure – Sleeved Butt Joint



REPLACE THIS EXAMPLE WITH YOUR OWN CAD

Figure – Double Lug Joint





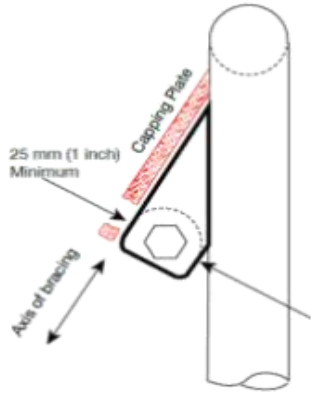
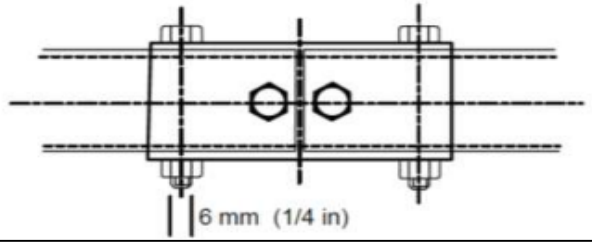


Figure – Sleeved Butt Joint



Bolted Members

If the rigidity is insufficient, "REJECT" will be displayed, so redesign with "EQ" dimensions.

Select Double Lug Joint or Sleeved Butt Joint before calculating.

		EQ	
F.5.12.2	Bolted Connection:	Select drop down:	EQ

F.5.3.1 All fasteners for removable tubing require crush bushings through the tubes. Inserts are not mandatory for outside sleeves and lugs for removable tubing.

F.5.12.4 Double lug joints must include caps on tabs at both ends.

		EQ		
F.5.12.3a	Lug thickness >= 4.5mm (0.177in) steel:		mm	N/A
F.5.12.3b	Perpendicular dimension >=25mm (1in):		mm	N/A

F.5.12.5 Double lug joints require a pin or fastener >= 10mm Grade 9.8 (3/8in Grade 8).

F.5.12.7 Sleeved butt joints require 4X pins or fasteners >= 6mm Grade 9.8 (1/4in Grade 8).

F.5.4.3 Any bolted non-suspension member must have an edge::distance ratio >=1.5.

Dimensions shown above from the edges of the holes to the end of each tube/tab >=1.5 x diame

Show all dimensions graphically.

		EQ		
F.5.4.3	Hole diameter / fastener size:		mm	N/A
	Distance to tube edge:		mm	N/A
	Distance to tab edge:		mm	N/A
	Minimum edge::diameter ratio >=1.5:			N/A